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and the black grouse (*Tetrao tetrix*). Most of the thirteen specimens examined were males.

Mammals.—Mr. Frederick True, in a letter to *Science*, asserts that he has found characters by which *Lynx canadensis* can be distinguished from *L. rufus* and the other Southern varieties. Examination of over sixty skulls showed that in all examples of *L. canadensis* the anterior condyloid foramen is *not* confluent with the foramen lacerum posterium, and that the visible portion of the presphenoid is flask-shaped, the convexity in front. In *L. rufus*, *maculatus* and *fasciatus* the two foramina are confluent as in the cats generally, and the visible part of the presphenoid is sagittate or linear. Mr. True, therefore, believes that there are two species of American lynxes, and that the confluence of the condyloid and lacerated foramina cannot in future be regarded as a distinguishing character of the *Æluroidea*.—Walter Heape (*Quart. Jour. Mic. Science*, Feb., 1886) contributes an article upon the development of the mole (*Talpa europea*), the ovarian ovum and the segmentation of the ovum. The epiblast of the vesicle and of the embryo is formed from the whole of the outer layer and by far the largest proportion of the inner mass of segments. The hypoblast is formed from the small remaining portion of the inner mass, and the mesoblast, subsequently, from both epiblast and hypoblast layers. Thus the division of the segmentation spheres, by Beneden, into epi- and hypoblast spheres from the time when the two first segments were formed, is incorrect.—Dr. O. Finsch has recently described a new species of wild pig (*Sus niger*) from New Guinea.

EMBRYOLOGY.¹

THE METAMORPHOSIS OF THE AMERICAN LOBSTER, HOMARUS AMERICANUS H. MILNE-EDWARDS. — The changes which the young lobster undergoes during the first six or seven weeks of its free existence, as a pelagic organism, constitute a veritable metamorphosis, which is apparently accomplished in the course of six ecdyses, or changes of the exoskeletal investment of the body. These molts, or ecdyses, occur at intervals of from four to fifteen or more days, if the larvæ are well fed. At each ecdysis a complete renewal of the exoskeleton occurs; the old cast skin being quite thin and transparent up to the fifth ecdysis, and retains the form of the body at the time of molting. The old skin is ruptured along the median dorsal line of the cephalothorax and at the point where the latter joins the abdomen; the tail is withdrawn after the head.

Inasmuch as some Arthropods undergo an ecdysis within the egg, the advanced eggs of the lobster have been carefully examined to determine whether a molt took place at the time of

¹Edited by JOHN A. RYDER, Smithsonian Institution, Washington, D. C.

hatching. Such is not the case, since the thin distinct inner membrane ruptured at the time of hatching is not a molted larval skin, but an egg-membrane which was developed within the ovary. This egg-membrane is invested at the time of oviposition by a much thicker coating of a viscid substance, which is continued into the flexible threads by which the eggs adhere together in clusters and are suspended to the setæ which fringe the abdominal appendages of the adult female. At the time of hatching the young hang for a short time more or less firmly to this inner membrane, grasping it with the rostral spine and telson.

The first stage.—This stage is the one which the young lobsters present at the time of hatching. They are essentially Schizopods during this and the succeeding three stages. During this stage the young have no abdominal appendages, and swim about as pelagic larvæ by the help of the outer rami or exopodites of the six hinder cephalothoracic pairs of appendages; the endopodites or inner rami of the six hinder cephalothoracic appendages are not used in locomotion during this stage, and are almost wholly subservient to the purpose of prehension. The telson is a single, very broad, somewhat triangular piece, with strong spines at either posterior angle. The total length of the larva at this stage is eight millimeters.

Second stage.—This stage follows the preceding abruptly and is preceded by an ecdysis three to six days after hatching. This ecdysis or molt must therefore be regarded as the first one. Upon its accomplishment the larva has increased 1.5^{mm} in length, as the young lobster is now 9.5^{mm} long. The second to the fifth abdominal somites have also acquired appendages.

Third stage.—This follows the preceding, and is preceded by a second ecdysis about the tenth to the fifteenth day after hatching. The penultimate or sixth abdominal segment also acquires a pair of biramous, lamellar appendages, which fold alongside of and reinforce the telson. The young animal now measures 11.5^{mm} in length.

Fourth stage.—This one succeeds the preceding, and is preceded by a third ecdysis on the fourteenth to the eighteenth day after hatching. The young lobster differs but little, except in size and the proportional strength of the successive pairs of appendages, from the foregoing stage, and now measures 13^{mm} in length. This and the preceding stage was apparently confounded by Professor S. I. Smith,¹ who seems to regard the two as representing but a single phase of development.

Fifth stage.—This phase of development of the lobster transforms the young creature at the end of about the third week very abruptly into a type very closely resembling the adults, and is

¹ The Metamorphoses of the Lobster and other Crustacea, Report of the U. S. Fish Commission, Part I, 1871 and 1872, pp. 522-537, pl. IX. (Figs. 38 and 39 of plate IX of that report represent very accurately the first and third stages.)

heralded by the fourth ecdysis or molt. The telson now closely resembles that of the adult, and on either side of it the broad lamellæ of the exopodites of the appendages of the penultimate abdominal segment become distinctly segmented for the first time into two movably articulated pieces. The flagella of the antennæ and antennules now become much longer, the former being as long as the cephalothorax. The appendages of the second to the sixth abdominal segments inclusive, are now much more strongly developed than hitherto, and together with the telson constitute the only organs of propulsion in swimming. The schizopodal characters of the six hinder cephalothoracic appendages have almost entirely disappeared at this stage; the exopodites of those appendages are almost entirely absorbed at the time of the fourth molt, and remain for a time as blunt, rounded tubercles near the bases of the legs, on the upper aspects of the latter. The first pair of abdominal appendages have not yet appeared; the symmetrical chelipeds are now well developed and are not carried in a pendant position, as in the preceding stages, but in that in which they are held by the adult, and when swimming they are extended forwards and parallel with each other. The young lobster now measures 14^{mm} long from the tip of the rostrum to the end of the telson; 16^{mm} from the tips of the extended chelipeds to the end of the telson; 18^{mm} from the tips of the extended antennæ to the extremity of the telson. The young lobster, towards the close of this stage, during the fifth week, becomes less partial to its earlier pelagic mode of life, and remains on the bottom a great part of the time. The color is now a bluish-green, with more or less brown in some cases, so that the animal is no longer so transparent as during the preceding stages.

Sixth stage.—This stage is attained between five and six weeks after hatching and, like the foregoing, is preceded by an ecdysis. The latter, unlike the previous molts, is hard and brittle, bluish in color and retains the form attained by the animal at the end of the preceding stage. The young lobster now measures 19^{mm} from the tip of the still bifid rostrum to the tip of the telson; 22^{mm} from the tips of the extended chelipeds to the end of the abdomen. The antennæ are now considerably longer than the cephalothorax, or proportionally almost as long as those of the adult; the total length of the animal from the tips of the extended antennæ to the end of the telson is now 29^{mm}. One of the chelæ is now also perceptibly larger than the other. The animal has not yet, however, assumed the adult condition, as there are still no appendages developed on the first abdominal segment.

Seventh stage.—This is also preceded by an ecdysis, and the young animal now measures 22^{mm} in length from the tip of the rostrum to the end of the telson; 36^{mm} from the tip of the antennæ to the tip of the telson. The pair of appendages on the first abdominal ring have now appeared as very short rudiments which

are quite unlike those of the adult both in form and size. The modifications of this pair of appendages, indicating the sex of the individual, have not yet appeared, however, and are probably not developed until after the next or seventh molt, when the young lobster entered upon the *eighth stage* of its free existence. There is a very decided inequality in the size of the two great "claws" or "pincers" at the end of the seventh stage. The young animal now manifests a more strongly marked disposition to remain on the bottom than during the preceding stage. This last-described stage is attained in about seven weeks after hatching.

It will be seen that as to the number of stages my observations are not in accord with those of either Smith or of Dannevig.¹ The work of G. O. Sars, on the development of the European lobster, I have not seen, but the large amount of material which I have had the opportunity to study in a series of tanks, under conditions admitting of very little chance of error, in the United States Fish Commission station at Wood's Holl, leads me to think that with the precautions which have been taken, I have not confounded or subdivided any stages, as I believe an alcoholic series which has been preserved of the stages above described will amply prove. With a slight rise in the temperature of the water, and an abundance of food, the fourth molt, or fifth stage, may be reached in twelve days, as later experience shows.—*John A. Ryder.*

THE MONSTROSITIES OBSERVED AMONGST RECENTLY HATCHED LOBSTERS.—At Wood's Holl a few double monsters were hatched out amongst the normal lobster larvæ. These monstrosities were all the more interesting from the fact that they proved in the most striking manner that double monsters must be developed in the meroblastic egg of the lobster in much the same way as in that of fishes.

Four forms of double monsters were observed:

First type.—This one had no eyes; the cephalothoraces of the two embryos were completely fused together laterally and anteriorly, while their abdomens were separate and diverged at a wide angle from each other.

Second type.—This form had a single eye anteriorly and on the line where the cephalothoraces of the two embryos were fused together; in other respects this form resembled the preceding.

Third type.—In this form the cephalothoraces of two embryos were fused laterally and anteriorly, and there was no median eye as in the preceding type, but a pair of eyes, the one representing the left eye of the left embryo, and the other the right eye of the right embryo, were developed.

Fourth type.—In this form the cephalothoraces of two embryos

¹ Beretning over Virksomheden ved Udklaekningsanstalten for Saltvandsfisk. 12mo. pp. 39, pls. 2. Arendal, 1885.

were fused together along their anterior dorsal aspects. There were four eyes developed, two to each embryo, and two distinct sets of mouth-parts and biramous, locomotive appendages.

In this last form the two embryos adhere together dorsally, and the two systems of limbs of the two nascent lobsters, which have obviously developed from a single blastoderm, enveloping one yolk, are directed away from each other. This relation of two perfectly formed embryos in the same lobster egg is exactly the reverse of that which is observed in vertebrates. For example, two embryo fishes which had been developed from the same blastoderm would, if primarily formed at exactly opposite sides of the blastodermic disk, finally be found to adhere together by their ventral aspects, so that their backs would look in opposite directions. These interesting data may in part be interpreted by the well-known fact that the neural aspect of an arthropod is ventral, while the neural aspect of a vertebrate is dorsal. This does not, however, afford a complete interpretation, since we find, not only in the case of a double vertebrate, but also in that of a similar invertebrate monster, that the median or unpaired organs of the two are often fused. This is the case in the double monsters of the lobster of the first, second and third types. Inasmuch as such structures as the alimentary canals and hearts of two such conjoined embryos are so fused, the question immediately arises, How was this accomplished? The answer seems to be that the fusion took place coincidently with the process of gastrulation and the subsequent gradual formation of the organs of the two embryos. This view of the matter is further substantiated by the fact that the four types described represent as many degrees of fusion or union. The question which now arises, however, relates to the way in which these different degrees of fusion of the two embryos were developed.

This may be explained, it appears to the writer, on *a priori* grounds, in the same way in which the different degrees of fusion or concrescence of double fish embryos were interpreted by Rauber, and since verified by other observers. That is to say, if two gastrulæ were developed at the edge of the same blastodisk, the degree and manner of their fusion would be determined by the width of the angle at which the two embryonic axes were primarily inclined to each other. This principle probably applies also in the case of the double monsters developed in the eggs of lobsters, and further extends the application of the doctrine and theory of concrescence.—*John A. Ryder.*